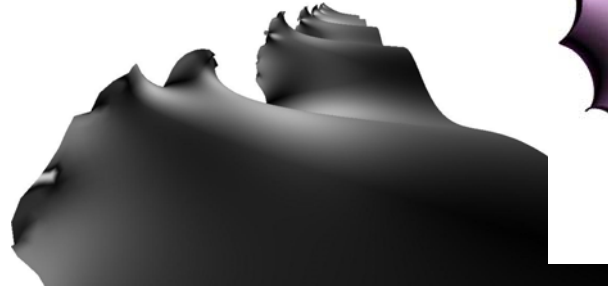


# Membranes and Metrics

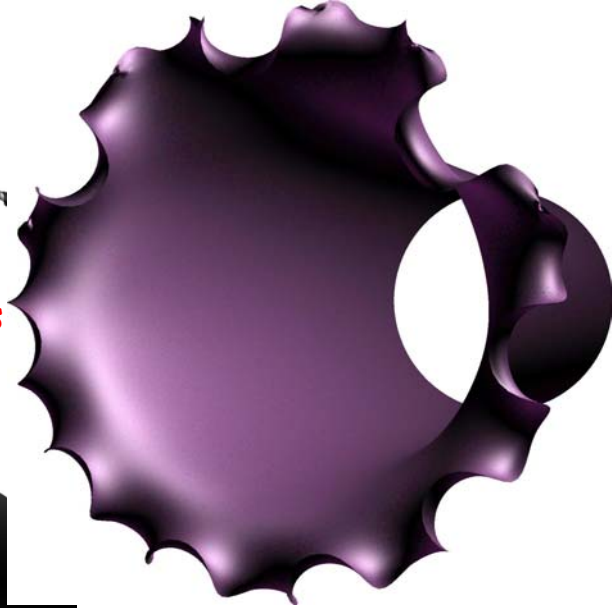
- Thin sheets, ranging from flowers to torn plastic, display a characteristic rippled edge.
- The rippled edges result from having stretched the sheet by varying amounts; the sheet spontaneously wrinkles up.
- Smoothly varying amounts of stretch can lead to complicated fractal shapes of the sheet.
- Can find exact shape of wrinkled edge in simple cases.



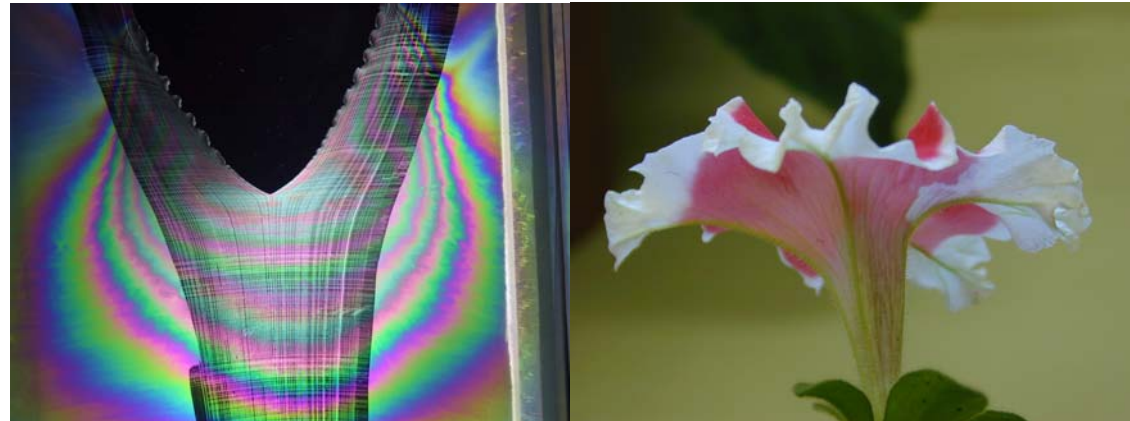
Numerical energy minima of sheets with non-flat metrics



Plastic stretches as it rips and the wrinkles grow most at edge and wrinkles.



Flower



Spencer Smith (undergraduate), Eran Sharon (postdoc), Benoit Roman (postdoc), and Michael Marder (PI) , The University of Texas at Austin MT/DMR/MPS 9877044  
Europhysics Letters **62**, 498-504 (2003)

## Introduction

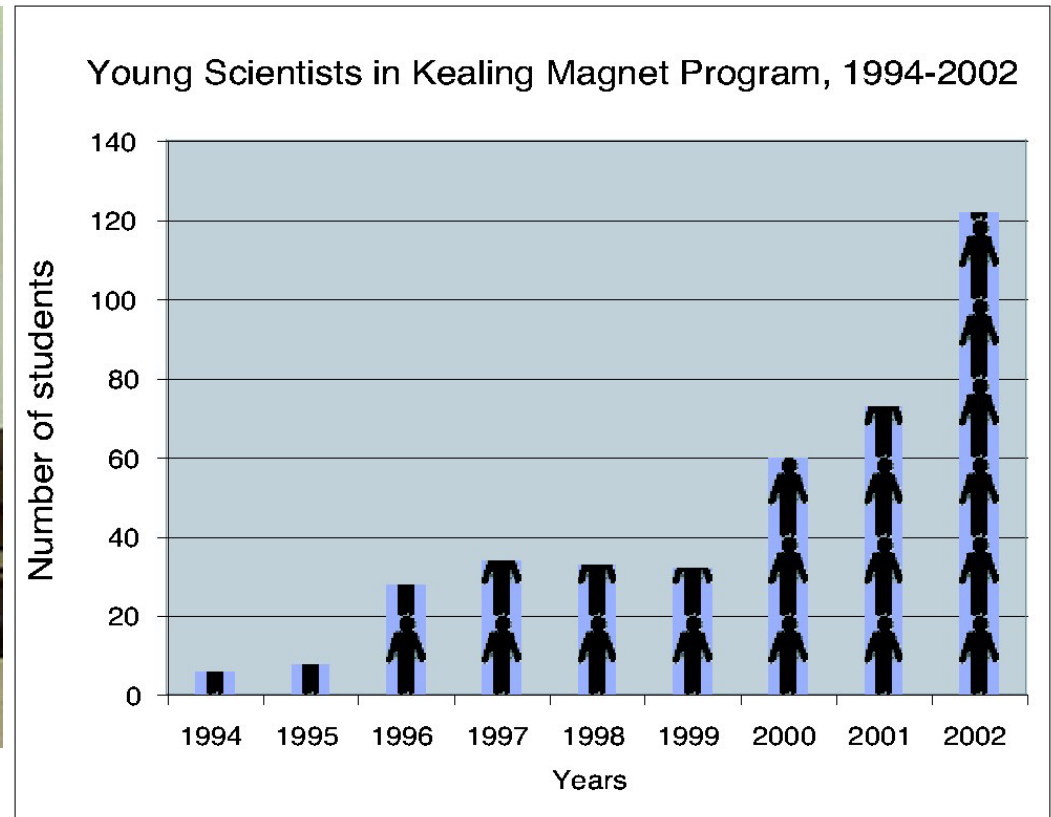
Previous dynamic fracture studies have often been concerned with the speed of crack propagation through a material, the branching that occurs when the crack speed approaches the sound speed in the material, and the path that a crack will take in a material under varying strains. The existing theory cannot predict these quantities for crack paths, but we believe that our studies of oscillating crack paths will provide a fresh perspective, perhaps providing details to complete the theory.

## Summary of results

We have studied crack paths in latex rubber sheets stretched in two orthogonal directions, and observed that originally straight cracks undergo a transition to oscillating paths as the amount of biaxial strain is increased. We mapped a phase diagram of these states, and from measurements of the amplitude and wavelength of the oscillation near the onset of the instability, find that this transition can be characterized as a Hopf bifurcation. Finally, we ruled out several possible mechanisms that could drive this instability.

# Young Scientists

- PI Marder directs program to provide access for kids from low SES schools to Austin's junior high magnet program.
- Special year-long sixth-grade classes prepare kids for rigorous academic level, and full-time counsellor supports them at junior high.



## Phase Diagram

The resulting paths for many runs are plotted as a function of strain. A boundary is drawn between straight cracks (open circles) and oscillating cracks (filled circles) to guide the eye. The limits at the top of the diagram exist because large strains in the sheet induce spontaneously running cracks, making it difficult to collect data for  $e > 2.6$ . As the y-strain becomes small ( $e < 1.4$ ) and approaches the x-strain, the wavelength of the oscillation becomes large (inset figure), causing difficulties in distinguishing straight cracks from long wavelength oscillating cracks.

## New Apparatus

A stretching apparatus currently being built will eliminate the amount of time required for each run, and will allow for a greater rate of data collection. The apparatus is designed with linear bearings riding on guide rails. An outer frame of these rails will support two perpendicular mobile rails. Riding on these rails, a collection of linear bearings with clamps will hold the sheet, and the moving rails will be extended, stretching the sheet. The result will be much more rapid data collection, enabling us to settle some remaining questions before proceeding to a long publication.